IMPROVING CIRCULARITY OF BUILDUING COMPONENTS

A CASE STUDY ON THE ENVIRONMENTAL PERFORMANCE OF FAÇADE SYSTEMS OF PREFABRICATED TIMBER BUILDINGS

Sabine DWORAK, David LANER

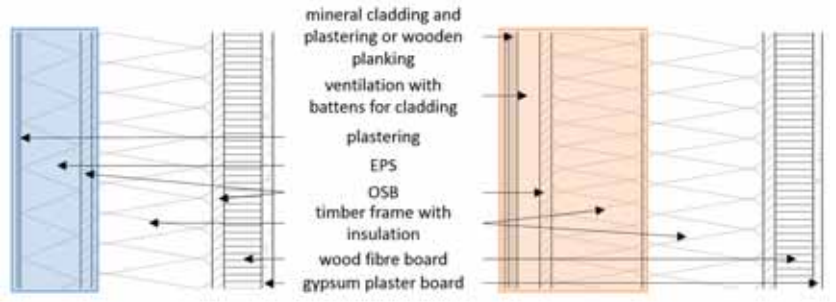
Introduction

Construction and demolition waste have been designated a priority waste stream by the European Union, due to increasing amounts and high potential for increasing re-use and recycling levels. Because the market share of pre-fabricated houses has been growing steadily in Austria, measures to improve circularity in the pre-fabricated building sector are urgently needed. The goal of the present study was to assess the environmental impact of three alternative façade systems for a pre-fabricated timber wall.

Methods

Life Cycle Assessment (LCA)

- Functional unit: **1 m²** wall with a lifespan of **60 years** (replacement after 30 years of conventional cladding)
- Façade alternatives:
  Version **A**: Conventional cladding (composite façade)
  Version **B**: Ventilated cladding (**B.1** and **B.2**, respectively with mineral cladding and plastering or planking), optimized for higher durability, lower maintenance and easier disassembly
- Impact categories:
  Global Warming Potential (**GWP**) over 100 years
  Cumulative Energy Demand (**CED**) of non-renewables



Alternative wall systems: left: construction with composite façade (version A), right: ventilated facade (versions B.1 and B.2)

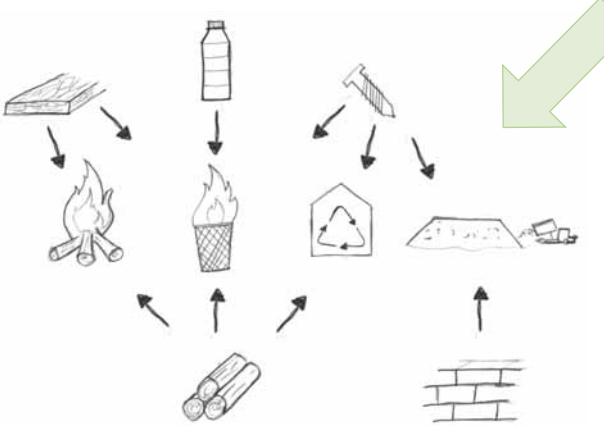


Illustration of End-of-Life (EoL) treatment pathways for materials (proportions vary according EoL scenarios)

The LCA study does not include erection, use, dismantling/demolition, because these phases are considered to be the same independent of the façade alternative. For the same reason, identical parts of the wall are neglected in the assessment.

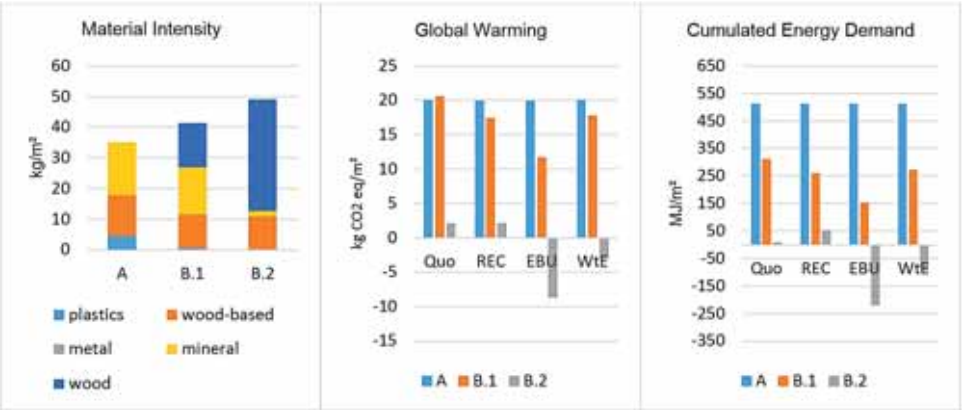
The following End-of-Life (EoL) treatment scenarios were considered:

- Status **Quo**: Represent the most likely treatment options for different waste streams currently in Austria.
- Recycling (**REC**): maximum recycling of wastes, re-use of mineral wool.
- Energetic Biomass Use (**EBU**): Untreated wood waste is directed to thermal utilization, mineral wool is re-used.
- Waste-to-Energy Plant (**WtE**): All combustible material is treated in a state-of-the-art WtE plant, the mineral fraction landfilled

Results and discussion

The ventilated façade system has a substantially **higher material intensity** (B.1, B.2), but **performs better** due to

- higher use of **renewable materials** (i.e. wood)
- **longer lifetime** and therefore more efficient material use
- better treatment and recycling due to **possible separation** of fractions by **dismantling**



Material input for assessed cladding systems (left); Results for global warming and cumulative energy demand for the different disposal options for the assessed cladding systems (middle and right)

Conclusion

The present study showed that despite a higher material demand, the ventilated façade system performed better than the conventional composite façade in terms of greenhouse gas emissions and consumed primary energy. The high mass share of wood, the longer lifetime, and the improved disassembly options allow higher quality utilization of building waste materials. Hence, due to optimized design, more material (and waste) can mean less environmental impact.

TU WIEN TECHNISCHE UNIVERSITÄT WIEN

Acknowledgments:
This research was carried out as part of the project "OpAF, Optimierung der Abfallvermeidung im Fertighausbau" funded by the VKS within the program "Abfallvermeidungs-Förderung der SVS für Verpackungen".

https://iwr.tuwien.ac.at/ressourcen

Authors
Sabine Dworak, David Laner
Institute for Water Quality and Resource Management
TU Wien
sabine.dworak@tuwien.ac.at